Simple Interest is not Simple

FORMULATED AND PUBLISHED BY

M. NAGARAJA VARMA, M. Sc.,

ANDHRA BANK

ALLAGADDA. Kurnool Dt. A.P.

Formulated in 1988

Other Articles by the Author

1. Formulae Employed in Banking - Mathematics Today - Jan 1987
2. Theorems in Banking Mathematics - the Mathematics teacher (india

VOLUME—23, No. 3 (1987)

Learned Readers are Requested to Send Their Views on This ARTICLE

ALLAGADDA - 518543

1-1-1993

Simple Interest is not Simple

Theorem :- If a principal amount P is to be paid beck in equal instalments of each A, spaced at equal intervals of time t, at simple rate of interest R, so that the Balance left is nil affer T Instalments, the Instalment A is given by

$$A = \frac{P\left[\sqrt{(x+2)^2+8xT} + (x+2)\right]}{4T}$$

Where $x = Rt$ for all $x > o$ and $T > 1$

Proof:- Simple Interest by itse f means that there will be no Interest on Interest. That is no Compounding of Interest. The theorem contemplates a Uniform rate of instalment(A)both in principal and Interest Repayment periods.

Principal Instalment

In simple Interest Instalments are appropriated to principal first, Only after the principal is fully repaid the Interest instalments begin. Henc

$$A_p = \frac{P}{N} \qquad -(1)$$

Where N is the number of principal Instalments.

Interest instalment :- When the Principal is fully repaid interest accrued till then will be shown as a separate Loan account. Interest stops to accrue further and interest instalments start then.

After Payment of Each principal instalment		Amount of Interest accrued after each principl instalment (Interest account)
1	-	Px
2	-	(P-A)x / p
3	-	(P-2A)x / p
.		
.		
N th	-	$\left[P-\frac{(N-1)A}{p}\right]x$

Total Interest accrued, $I = \sum_{1}^{N} \left[P-\frac{(N-1)A}{p}\right]x$

$$= \frac{\left[2p-\frac{(N-1)A}{p}\right]Nx}{2}$$

Then Interest instalment is

$$A_i = \frac{I}{n} = \frac{\left[2p-\frac{(N-1)A_p}{p}\right]Nx}{2n} \quad ---(2)$$

Where, n is the number of interest instalments.

Since, total number of instalments, $T = N+n$

$$n = T-N \quad ----(3)$$

Substituting (3) in (2)

$$A_i = \frac{\left[2P-\frac{(N-1)A}{p}\right]Nx}{2(T-N)} \quad ----(4)$$

Inorder to have a uniform instalmint throught the repayment period

$$A_p = A_i = A$$

Thus (4) becomas

$$A = \frac{[2p-(N-1)A]}{2(T-N)} Nx$$

$$= \frac{PNX}{T-N} - \frac{N(N-1)Ax}{2(T-N)}$$

$$A + \frac{N(N-1)Ax}{2(T-N)} = \frac{PNx}{(T-N)}$$

$$1 + \frac{N(N-1)Ax}{2(T-N)} = \frac{PNx}{A(T-N)}$$

$$= \frac{N^2 X}{(T-N)} \quad (\text{Since. } \frac{P}{A} = N \text{ by Ep (I)})$$

On adjusting terms on both sides we get,

$$N^2 x + N(x+2) - 2T = 0 \qquad \ldots\ldots (5)$$

Solving this quadratic aquation for N and taking only the positive root, we get

$$N = \frac{\sqrt{(x+2)^2 + 8xT} - (x+2)}{2x} \qquad -(6)$$

Now, substituting for N in Eq. [1]

$$A = \frac{2Px}{\sqrt{[x+2]^2 + 8xT} - [x+2]}$$

On rationalisation, we get

$$A = P\left[\frac{\sqrt{(x+2)^2 + 8xT} + (x+2)}{4T}\right] \qquad \text{- - - (QED-1)}$$

Thus the Theorem is proved.

Hence, dear reader, do you agree that simple interest is not simple now ? In practice, the fromula will be very much useful to find instalments for simple interest loans, Some Banks and financlal institutions charge simple interest for Housing Loans,

Example;- P-Rs. 1,00,000 , R-10% , t- Monthly = $\frac{1}{12}$,x= Rt= 0,00833

T = 60 monthly instalments.

with the above formula we get, A = Rs. 2,017-77

It is of interest to note that the formula contains only the total number of instaiments T and neither N nor n,

Since, T is number of instalments it takes positjve integral values, 1, 2, 3 .....

X, A, P are positive real numbers.

Since. A and p are positive

$$A \underline{\leq} P$$

Case-1— When A = P

Equating A and P the formula yields

X = T-1

Wnen T = 1 , then X = 0

x =0 only in case of interest free loan. (X =Rt =0 . when R =0)

Hence, for all X>0 —> T > 1

Casa-2 Wnen A < P (practically true, since instalment is always less than Principal)

$$0 < A < P$$

$$0 < \frac{A}{P} < 1$$

Substituting for A from formula

$$0 < \frac{\sqrt{(X+2)^2 + 8XT} + (X+2)}{4T} < 1$$

and finally, we get

$$0 < X < T-1$$

Now, when $T=1$ this inequality becomes

$$0 < X < 0$$

This is a mathematical Contradiction and impossible. Henee, $T \neq 1$

The formula will not hold good for $T=1$

Hence. fcr all $x > 0$ ——> $T > 1$

Case-3 When $A > P$

$$A > P > 0$$

$$0 < \frac{P}{A} < 1$$

Substituting for A and on manipulation we get

$$0 < T-1 < X$$

For $T=1$

$$0 < 0 < X$$

Which again is a contradiction and hencc the formula will not hold good for $T=1$

Hence, from the three cases above, it is clear that the formula holds good for $T=1$ only when $x=0$, which is the case of $R=0$. That is interest free loan. But for any $x > 0$ the formula will not hold good for $T=1$. This always is the case since all loans carry some interest so that $x > 0$

Hence, we can generalise that for all $x \geq 0$ the formula holds good for all integral, $T > 1$ ———(QED-2 .

The impossibility of the formula for T =1 demonstrates the physical reality that it is impossible to appropriate two loan accounts (here one for principal and the other for interest) with a single instalment.

The contradictions in cases 1 to 3 thus confirm that logic behind mainfaining two seperate accounts.

T =1 only when x =0. This demonstrates the truth thaf for interest free loan, there will be only one account-Principal a/c (interest a/c being Absent) and that single a/c can be repaid in a single instalment.

Thus, the formula demonstrates physical truth with the help of mathematical contradiction. besides giving values of A when T > 1

When, Einstein derived the famous Mass-Energy equation $E = mc^2$ it was thought of as the result of mathematical perversion without any physical truth in it. Later. with the Invention of the Atom Bomb. the truth of Mass-Energy relation as revealed by the equation came to light.

Note-1 Here, our formula reveals the truth that It is impossible to appropriate two loana/cs with a singie instalment. At the same time it never denies the exlstence of a formula for a single instalment when X > 0

It is obvious that for T =1 the relevant formula is

$$A = P(1+X))$$

Note-2 With a slight modification by trial and error the formuia can be made to yield the above formula. This is by putting 8x (T+x) in the square root for 8xT.

$$A = P\left[\frac{\sqrt{(x+2)^2 + 8x\ (T+x)} + (x+2)}{4T}\right]$$

$$= P(1+x)$$

Note-3 In practice $0 < X < 1$

Formulated by **M. Nagaraja Varma**, M. Sc., in 1988

Printed at to:- Sri Laxmi Ranga Printres, Allagadda.